

What is claimed is:

- 1 1. An airfoil assembly comprising:
 - 2 an airfoil having a radially proximal end and an open radially distal end, a
 - 3 hollow pocket formed in the airfoil beginning at the distal end and extending radially
 - 4 inward therefrom;
 - 5 a tip insert at least partially recessed within the pocket, the tip insert having a
 - 6 radially proximal end and a radially distal end;
 - 7 at least one spring operatively engaging the airfoil within the pocket and the
 - 8 tip insert to bias the tip insert to a predetermined recessed position, the tip insert
 - 9 being radially outwardly movable against the bias of the spring from the
 - 10 predetermined recessed position up to a predetermined extended position; and
 - 11 an abutment surface within the pocket for engaging at least one of the tip
 - 12 insert and the spring so as to limit the extension of the tip insert to the predetermined
 - 13 extended position.
- 1 2. The airfoil assembly of claim 1 wherein in the predetermined recessed
- 2 position, the distal end of the tip insert is substantially flush with the distal end of the
- 3 airfoil.
- 1 3. The airfoil assembly of claim 1 wherein in the predetermined recessed
- 2 position, the distal end of the tip insert is one of recessed and extended with respect
- 3 to the distal end of the airfoil.
- 1 4. The airfoil assembly of claim 1 wherein the spring and the tip insert are a
- 2 unitary construction.
- 1 5. The airfoil assembly of claim 4 wherein the tip insert includes a tip portion, a
- 2 stop flange and a cantilever spring interposed therebetween, the stop flange
- 3 providing the abutment surface.
- 1 6. The airfoil assembly of claim 5 further including one or more pins extending
- 2 through the pocket in the airfoil for engaging the cantilever spring.

1 7. The airfoil assembly of claim 6 wherein, in the predetermined extended
2 position, the cantilever spring engages the one or more pins and the stop portion of
3 the tip insert.

1 8. The airfoil assembly of claim 1 wherein the abutment surface includes a
2 stepped surface on the airfoil for engaging a substantially corresponding stepped
3 surface on the tip insert.

1 9. The airfoil assembly of claim 1 wherein the abutment surface includes one or
2 more pins extending through the pocket in the airfoil for engaging a cutout in the tip
3 insert.

1 10. A turbine engine system comprising:
2 a compressor including a stationary ring having an inner peripheral surface,
3 wherein the ring substantially surrounds a rotor with at least one disk on which a
4 plurality of airfoils are attached;
5 at least one of the airfoils having a radially proximal end and an open radially
6 distal end, a hollow pocket formed in the airfoil beginning at the distal end and
7 extending radially inward therefrom;
8 a tip insert at least partially recessed within the pocket, the tip insert having a
9 radially proximal end and a radially distal end;
10 at least one spring operatively engaging the airfoil within the pocket and the
11 tip insert to bias the tip insert to a predetermined recessed position, wherein a
12 clearance is defined between the radial distal end of the tip insert and the inner
13 periphery of the ring when the tip insert is in the predetermined recessed position,
14 the tip insert being radially outwardly movable against the bias of the spring
15 from the predetermined recessed position up to a predetermined extended position,
16 thereby reducing the clearance between the radially distal end of the tip insert and
17 the inner periphery of the ring, whereby the power and efficiency of the engine is
18 increased; and

19 an abutment surface within the pocket for engaging at least one of the tip
20 insert and the spring so as to limit the extension of the tip insert to the predetermined
21 extended position.

1 11. The airfoil assembly of claim 10 wherein in the predetermined recessed
2 position, the distal end of the tip insert is substantially flush with the distal end of the
3 airfoil.

1 12. The airfoil assembly of claim 10 wherein in the predetermined recessed
2 position, the distal end of the tip insert is one of recessed and extended with respect
3 to the distal end of the airfoil.

1 13. The airfoil assembly of claim 10 wherein the spring and the tip insert are a
2 unitary construction.

1 14. The airfoil assembly of claim 13 wherein the tip insert includes a tip portion, a
2 stop flange and a cantilever spring interposed therebetween, the stop flange
3 providing the abutment surface.

1 15. The airfoil assembly of claim 14 further including one or more pins extending
2 through the pocket in the airfoil for engaging the cantilever spring.

1 16. The airfoil assembly of claim 15 wherein, in the predetermined extended
2 position, the cantilever spring engages the one or more pins and the stop portion of
3 the tip insert.

1 17. The airfoil assembly of claim 10 wherein the abutment surface includes one of
2 stepped surface on the airfoil for engaging a substantially corresponding stepped
3 surface on the tip insert and at least one pin extending through the pocket in the
4 airfoil for engaging a cutout in the tip insert.

1 18. The airfoil assembly of claim 1 wherein the spring has an associated spring
2 rate, the spring rate being such that, when the rotor turns at one of about 2300 rpm

3 and about 3000 rpm, the tip insert begins to move away from the predetermined
4 recessed position.

1 19. The airfoil assembly of claim 1 wherein the spring has an associated spring
2 rate, the spring rate being such that, when the rotor turns at one of at least about
3 3000 rpm and at least about 3600 rpm, the tip insert is at the predetermined
4 extended position.

1 20. An airfoil assembly comprising:
2 an airfoil having a radially proximal end and an open radially distal end, a
3 hollow pocket formed in the airfoil beginning at the distal end and extending radially
4 inward therefrom;
5 a tip insert at least partially recessed within the pocket, the tip insert having a
6 radially proximal end and a radially distal end;
7 at least one spring operatively engaging the airfoil within the pocket and the
8 tip insert to bias the tip insert to a predetermined recessed position, the tip insert
9 being radially outwardly movable against the bias of the spring from the
10 predetermined recessed position up to a predetermined extended position; and
11 means for limiting the amount of extension of the tip insert to the
12 predetermined extended position.